DEVELOPMENT OF A PLASTICS CHARGE CASE FOR THE 7"2 PROJECTOR CHARGE ANTI-SUBMARINE WEAPON

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UNITED STATES NAVAL ORDNANCE LABORATORY, WHITE OAK, MARYLAND

DEVELOPMENT OF A PLASTICS CHARGE CASE FOR THE 7"2 PROJECTOR CHARGE ANTI-SUBMARINE WEAPON

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ABSTRACT: This report contains data and test results on the development of a high density polyethylene charge case as a replacement for the metal case which has been used since inception of the 7"2 Projector Charge Anti-Submarine Weapon. Several materials and case designs which were investigated are discussed relative to their performance characteristics.

The results of this study show that the range of the weapon is increased by approximately 15 meters when the high density polyethylene case is used. In addition, the case is less susceptible to water leakage during storage, is not affected by salt water corrosion, and can be produced more economically than all-metal cases. Finally, the hazard to personnel in the area of the projector mounts has been markedly reduced.

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DEVELOPMENT OF A PLASTICS CHARGE CASE FOR THE 7.2 PROJECTOR CHARGE ANTI-SUBMARINE WEAPON

This report contains information relating to the development of a plastics projector charge case to serve as a replacement for the metal case now being used in the 7.2 Projector Charge Anti-Submarine Weapon.

The work has been supported by WEPTASK RUSD 2A-000/212-1/F008-15-003, and has been carried out over the period from July 1958 to June 1962. It is believed that the plastics case designs and the fabrication techniques evaluated in this study will be useful in the design of plastics cases and housings for future naval applications. Insufficient data were collected, however, on the long-term aging characteristics of the plastics cartridge case. The experimental work performed in this experiment is limited in both scope and time.

R. E. ODENING
Captain, USN
Commander

ALBERT LIGHTBODY
By direction

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REFERENCES

(a) NOLTR 61-4 "Development of a Lightweight Plastics Cartridge Case - Final Report No. 5," Prosen, S. P., Johnson, W. T., Barnet, F. R., Mar 27, 1961

(b) "Methods for Joining Plastics Parts," A. J. Cheney, W. E. Ebeling, Society of Plastics Engineers Technical Conference, 1958

(c) "Spin Welding Aerosols of 'Zytel' Nylon Resin," W. F. Ebeling, R. L. Miller, SSL No. 171Z, E. I. du Pont de Nemours and Co., Inc.

(d) NWL Letter 8010/1-3 of 20 Nov 1962 to Cdr, NOL. Plastics Charge Cases for 7.2 Projector Charge; Ballistic Evaluation of PPE Lot

(e) NOL Letter 8010 Ser 6105 of 24 Sep 1962 to BuWeps; Plastics Cartridge Case for 7.2 Projector Charge; recommendation for release to production of

(f) WS-2457, Cartridge Case, Plastic for 7.2 Projectile

(g) LD-515899 and Drawings Listed Thereon

(h) LD-548302 and Assembly Drawing 2293603

INTRODUCTION

1. The "Hedgehog" 7.2 Anti-Submarine Weapon is a depth charge which is propelled from the deck of a ship by a projector charge of smokeless powder. The weapon is mounted on a firing post, as shown in Figure 1, and the projector charge, which is held in a container fitted into the weapon tail tube, is ignited by an electrically fired primer. The gases produced by ignition of the charge propel the weapon to the target area, which is located an average distance of 261 meters (855 feet) from the ship. The case base separates from the main case body and remains at the firing post, as shown in Figure 2.

2. The projector charge cartridge case which has been in use since inception of the weapon is of two-piece construction. Both the main body of the case and the end cap, which contains the primer, are formed of metal. The two pieces are joined together after loading with a compound composed of zinc oxide (ZnO), litharge (PbO), and glycerine. The metal case is shown in Figure 3. This case design is deficient in several areas. First, when ejected from the weapon tail tube, the edges of the end cap split causing hazardous fragmentation. Second, the bonding material sometimes deteriorates, permitting water to get to the propellant. This results in a marked reduction in the range of the weapon. Third, the field ranges vary from round to round due to poor gas sealing between the case body and the walls of the tail tube. These problems made the existing case undesirable, and the development of a new case design was suggested.

3. The Non-Metallic Materials Division of the Naval Ordnance Laboratory had conducted a successful research program leading to the development of a plastics cartridge case for the 105mm Howitzer (see ref. (a)). Based on the body of data collected in this study, the decision was made to undertake the development of a plastics charge case for the 7.2 Anti-Submarine Weapon. This report presents information and data relevant to the design and fabrication of an optimum plastics projector charge case.

PLASTICS PROJECTOR CHARGE CASE REQUIREMENTS

4. The criteria of construction and performance for the plastics projector charge case are summarized below:

a. The case must not produce hazardous fragmentation when the weapon is fired.

b. The case must be watertight over long periods of storage.

c. The main body of the case must obturate and form an effective gas seal with the walls of the weapon tail tube.

d. Electrical continuity between the primer and the weapon tail tube wall must be maintained.

e. The maximum pressure developed in the tail tube upon ignition of the propellant must not exceed 1,265 Kg/cm^2 (18,000 psi) at 50°C (120°F).

f. The cartridge case must be sufficiently rugged to withstand handling and assembly requirements.

g. The plastics material selected must be completely compatible with the propellant in use.

h. The cartridge case material must be chemically and dimensionally stable during storage and in operation between the temperature limits of -18°C (0°F) and 50°C (120°F).

On the basis of the performance requirements outlined and in consideration of the relatively large quantity of cases used in this application, it was decided that an injection molded thermoplastics projector charge case would be most suitable.

EXPERIMENTAL WORK

5. Projector Charge Case Design. The overall dimensions of the plastics charge case were predetermined, since they had to be identical to those of the metal case. Five case configurations were designed and submitted to performance and evaluation tests. A metal contact cup was necessary on all cases in order to complete the circuit for the electrically fired primer. Three contact cup designs were evaluated: a brass snap-in cup, a brass molded-in cup, and a machined steel cup. The steel cup was premachined, placed in the mold, and the main body of the case injection molded into it. Two basic case closure designs were selected for evaluation: (a) a snap-close joint and (b) a tongue-and-groove spin-welded joint. The case designs are shown in Figures 4 and 5.

6. Spin-Welding. In order to evaluate a projector charge case designed with a tongue-and-groove spin-welded joint, techniques for spin-welding the case sections together were developed. A spin-welding fixture (see Fig. 6) was designed and built. The end cap was held stationary in the base of the fixture, while the main case body was gripped by the holder and spun until friction heating and welding occurred. The joint integrity was tested using the test jig shown in Figure 7. The test specimen was fitted into the jig and internal hydraulic pressure applied until failure occurred.

7. Mold Design. The injection mold used in the development of the plastics projector charge case is shown in Figure 8. Since several different case designs were to be studied, the mold was built with removable inserts so that changes in charge case details could be made without rebuilding the entire mold. The mold was constructed with two

cavities; one for the main body of the charge case, and the other for the end cap. Two unique features were built into the mold: (1) Hydra-coil springs were used to lift the main body off the center core pin before removal of the case by the stripper ring, and (2) a ring runner was used to provide good flow characteristics around the core pin.

8. Materials Study. Three thermoplastics molding materials were selected for evaluation in this study: polypropylene, polycarbonate, and linear polyethylene. Prior to molding the charge case each material was submitted to propellant compatibility studies. The propellant used in this application was smokeless powder, type SPDN 9665. Compatibilities were determined by storing molded tensile bars and discs in closed containers over a quantity of propellant at 52°C (125°F) and 71°C (160°F) for 28-day periods. The specimens were then tested for change in properties as a result of the exposure. Finally, cases were then molded for firing tests and evaluation. On the basis of the firing range results, the most suitable molding material was selected and subjected to environmental tests. Cases were exposed both in and out of the weapon tail tube to determine final suitability and handling characteristics after simulated long-term storage.

RESULTS

9. Projector Charge Case Designs. Charge case Designs A, D and E were molded using linear polyethylene molding material (Marlex type 6015; density 0.96 gm/cm^3, M. I. 1.5 dg/min) and fired after conditioning at -18°C, ambient and 52°C. Firing results are presented in Tables 1, 2 and 3. Design E was selected for further studies for the projector charge case application. Typical field locations of Design E charge cases, fired at ambient conditions, are shown in Figure 9.

10. Spin-Welding. Preliminary tests conducted on the three materials selected for study indicated that all possessed good spin-welding characteristics. The welding parameters (i.e., spinning speed, in-motion time, etc.) were evaluated for each material, and are recorded in Table 4. The joint strengths for ten typical linear polyethylene case welds are presented in Table 5. Ultimate joint strengths in excess of 90% of the tensile strength of the virgin material were recorded.

11. Mold Design. Operation of the injection mold was satisfactory in all respects. The Hydra-coil springs performed as expected, and the ring runner provided good flow characteristics. When optimum molding cycles were used, flow and weld lines could not be observed in the case body.

12. Materials Study. The results of the propellant compatibility studies (see Table 6) showed that none of the three materials were affected

appreciably by exposure to the propellant volatiles. When projector charge cases were molded and fired, however, polypropylene was found to be unsatisfactory for this application (see Table 7). Range performance and fragmentation characteristics for polycarbonate and linear polyethylene were found to be satisfactory for all firings (see Tables 8 and 9). The obturating properties of linear polyethylene, however, were found to be superior to those of polycarbonate. Linear polyethylene having a density of 0.960 gm/cm^3 and a melt index of 1.5 dg/min was selected for the charge case design.

13. After preliminary selection of linear polyethylene as the projector charge case material, cases were molded and submitted to environmental tests. Typical test results are presented in Tables 10, 11 and 12. The cases were found to be satisfactory in all respects. Ten cases which had been loaded and exposed to 37 days of JAN cycling were fired at ambient conditions. Performance was satisfactory. The test results are shown in Figure 10.

DISCUSSION

14. Projector Charge Case Design. The primary case design variables which were in need of resolution for this study were: (a) the electrical contact cup design, and (b) the method of case closure. The evaluation of the snap-in brass contact cup (Design D) indicated that the design was not suitable. The cup split off the molded case base and produced hazardous fragmentation when the rounds were fired. Two thicknesses of brass (0.16 cm and 0.08 cm) were tested, but no change in performance could be noted. The molded-in cup (Design C) was found in preliminary laboratory studies to be unsatisfactory because the plastics case base area was weakened. The steel contact cup, however, is locked in place on the case body by the molding process (Design E). The cup is designed so that a thin section is created in the case base for separation of the base and body with minimum fragmentation. Results of the firing tests showed that the extent of fragmentation was markedly lower than for other case designs. In addition, no fragmentation of the steel contact cup occurred. A typical fragmentation pattern for 10 rounds of Design E configuration is shown in Figure 11.

15. Two basic types of case closure were investigated: (a) the snap joint and (b) the spin-welded joint. The snap-jointed cases were found to be unsatisfactory because of three major problems which developed: (1) the joint leaked in JAN cycling tests, (2) the joint tended to override itself when placed under the 30 kilogram load of the weapon, and (3) excessive fragmentation of the end cap occurred when the case was fired. On the basis of these results, the snap-joint was eliminated as a possible design.

16. Three spin-welded case closure joints were investigated. Case Design C, with the tongue-and-groove joint located in the body was

unsatisfactory. The groove sidewalls deformed during the welding process due to friction heating, and inferior joints resulted. The designs with the joint located in the end cap presented no problems. The cases with the deep-depth groove in the end cap (Designs B and E) were superior, however. The shallow-groove spin weld (Design A) was found to separate occasionally when the case was fired in the field.

17. Spin Welding. The use of spin welding techniques to provide a reliable and positively sealed joint between the two case halves was selected at the beginning of the development work. Studies were made by several private industries which were useful in the design of the clamping fixture and in selecting the proper parameters for study. See references (b) and (c). The preliminary tests showed that the three materials chosen for study could be successfully jointed by spin welding, and the use of a snap-joint closure was dropped from further tests. Selection of the proper welded joint location and configuration was made on the basis of performance in internal hydraulic pressure tests.

18. Mold Design. The function of the Hydra-coil springs used in this mold was to lift the case body off the center pin so that complete ejection could be accomplished without stripping off the case flange. Performance was satisfactory in this respect. The ring runner also operated satisfactorily. A flash ring gate was originally designed into the mold; however, separation of the case components from the runner was found to be difficult when polycarbonate material was molded. The inserts were therefore redesigned for tunnel gates, which performed satisfactorily.

19. Materials Study. Initial firing tests on the three candidate materials were conducted after ambient preconditioning. It was found that the polypropylene material was unsatisfactory. Examination of case fragments after firing indicated that a brittle type of failure had occurred in every round. Fragments were large and numerous; in some rounds the cases were found to be split along their entire length. On the basis of these observations and an analysis of the firing data, polypropylene molding materials were excluded from further testing.

20. Range performance data was satisfactory at all temperature conditions for both linear polyethylene and polycarbonate cases. Fragmentation characteristics for both cases were excellent; fragments were limited to two to three small plastics pieces per round. The cases separated in a clean manner at the base, and the main body of the case stayed with the weapon on its flight to the target. The gas sealing properties of the polycarbonate were inferior to polyethylene, however. This characteristic was attributed to the greater rigidity of the polycarbonate. Additional performance data for polyethylene and polycarbonate charge cases are given in reference (d).

21. The selection of a suitable molding cycle is important to the ultimate performance characteristics of a thermoplastic material.

Preliminary studies were made on each of the materials evaluated to assure that the molding cycle was satisfactory. The optimum cycle was then used in the molding of the test specimens for firing and environmental studies. The injection molding conditions used for linear polyethylene are presented in Table 13.

22. It is recognized that the selection of materials investigated in this study was limited. The nature of the development, however, was such that extensive evaluation of a wider variety of thermoplastic materials could not be carried out. The material selected as a result of this work is not to be considered unique for this application, but instead as one of several molding materials which could be expected to perform satisfactorily in this and similar applications.

CONCLUSIONS

23. The studies carried out in the development of a plastics projector charge case for the 7".2 Anti-Submarine Weapon show that a plastics material can perform satisfactorily in cartridge case applications. The successful development of such an item requires, however, that special attention be given to material and design parameters and to the operational requirements of the specific application. The cartridge case developed in this study met the initial design objectives, and weapons specifications and lists of drawings were prepared (ref. (e), (f), (g), and (h).

RECOMMENDATIONS

24. It is recommended that the plastics projector charge case for the 7".2 Anti-Submarine Weapon be released to production and placed in fleet use. It is further recommended that consideration be given to the use of plastics materials in other ordnance items with similar operating characteristics. A study of stress cracking and aging characteristics was not carried out in this program. It is therefore reccommended that special attention be given to studies of this subject in future tasks.

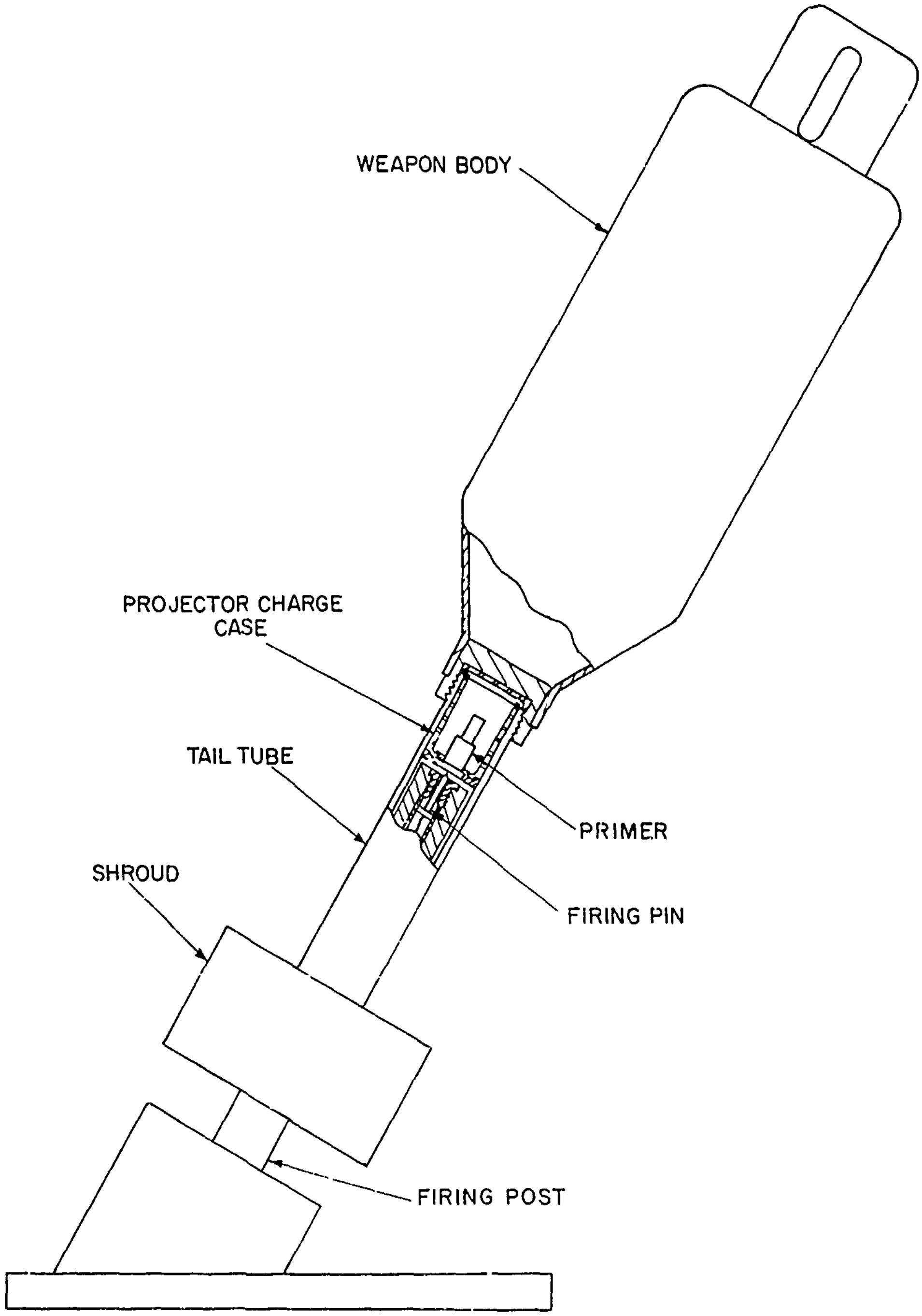


FIG. 1 7".2 ANTI-SUBMARINE WEAPON ASSEMBLED AND MOUNTED FOR FIRING

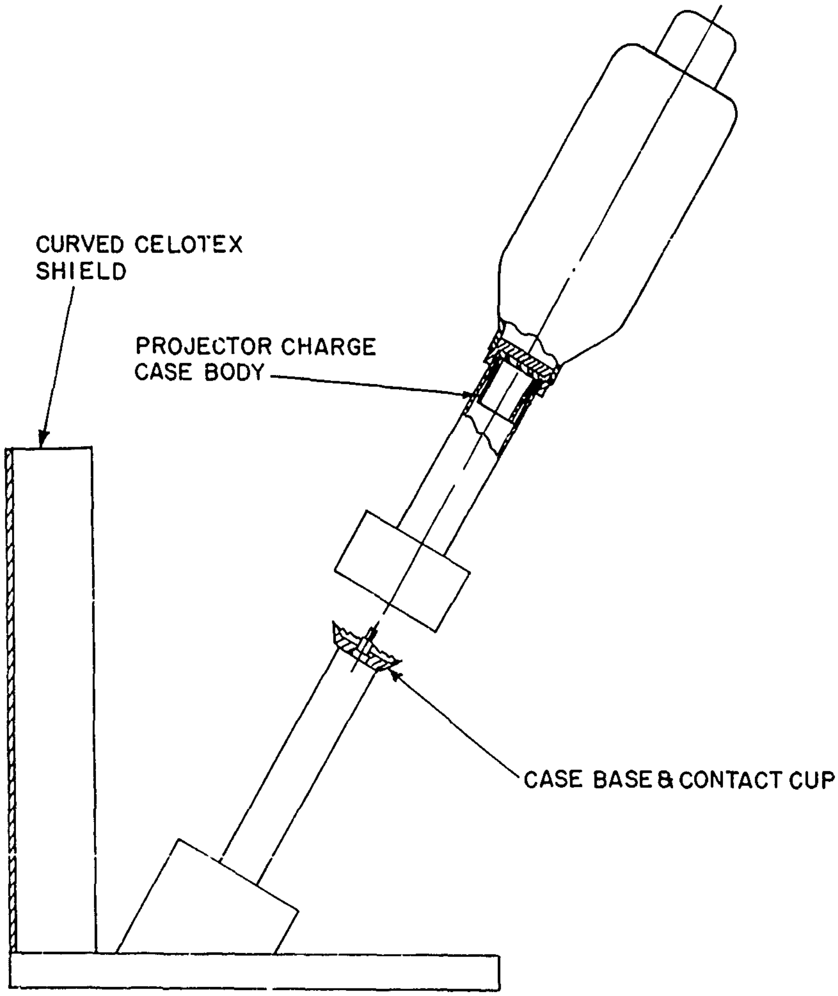


FIG. 2 7".2 ANTI-SUBMARINE WEAPON PROPELLED FROM FIRING POST

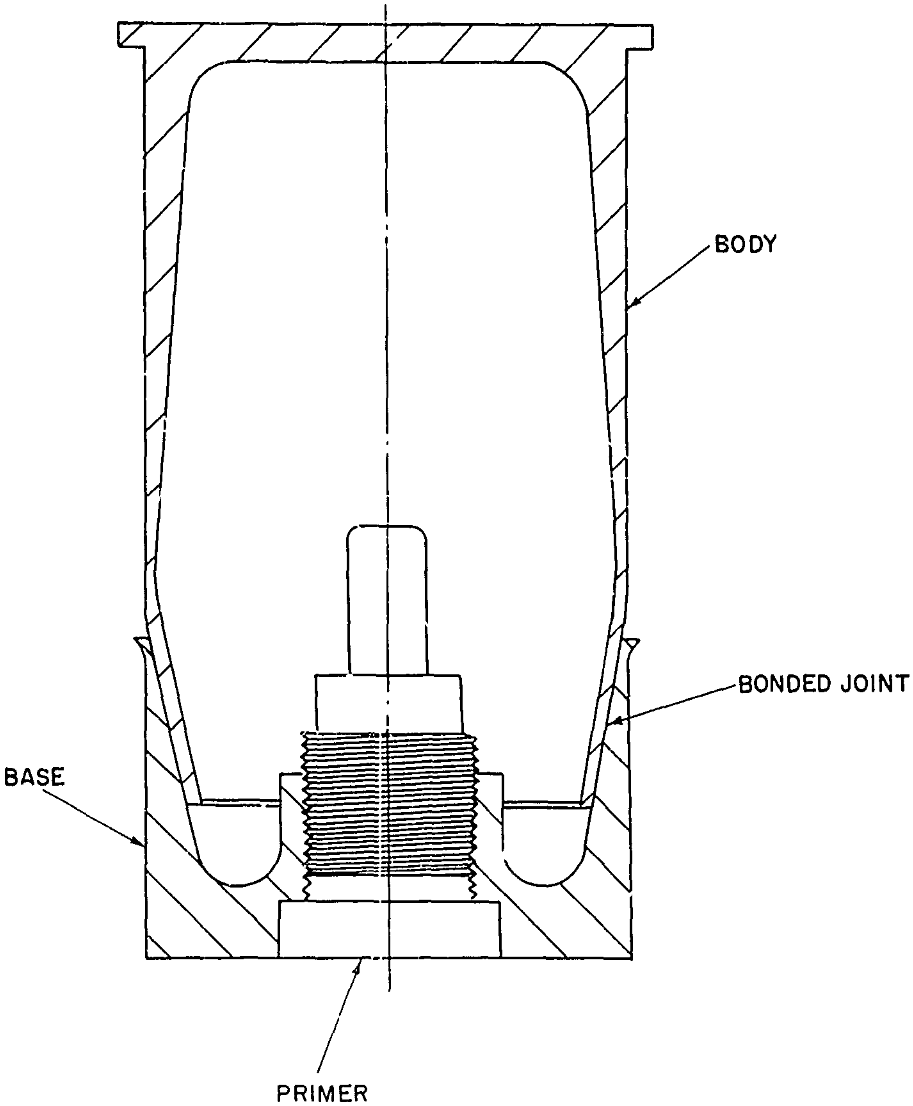
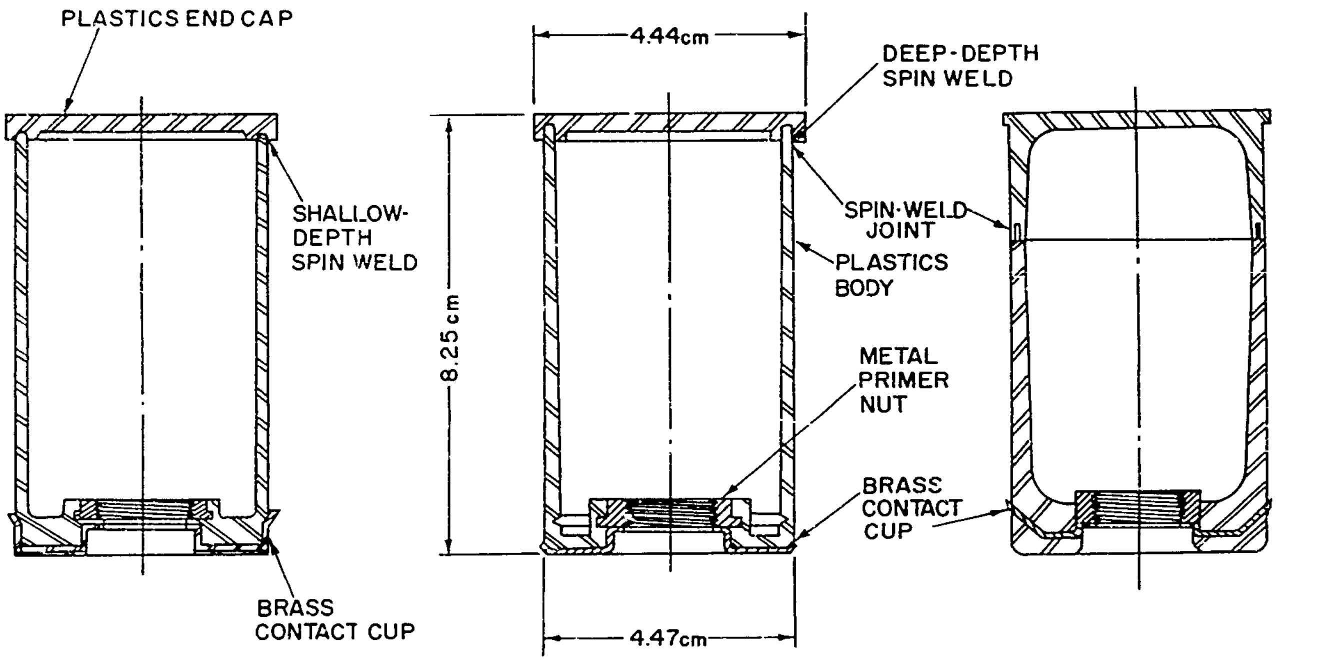


FIG. 3 METAL PROJECTOR CHARGE CARTRIDGE CASE CONSTRUCTION (MARK 2 MOD 0)



SNAP-IN CUP WITH SPIN WELD IN END CAP

DESIGN A

SNAP-IN CUP WITH SPIN WELD IN END CAP

DESIGN B

MOLDED-IN CAP WITH SPIN WELD IN SIDE WALL

DESIGN C

FIG 4 PLASTIC PROJECTOR CHARGE CASE DESIGNS

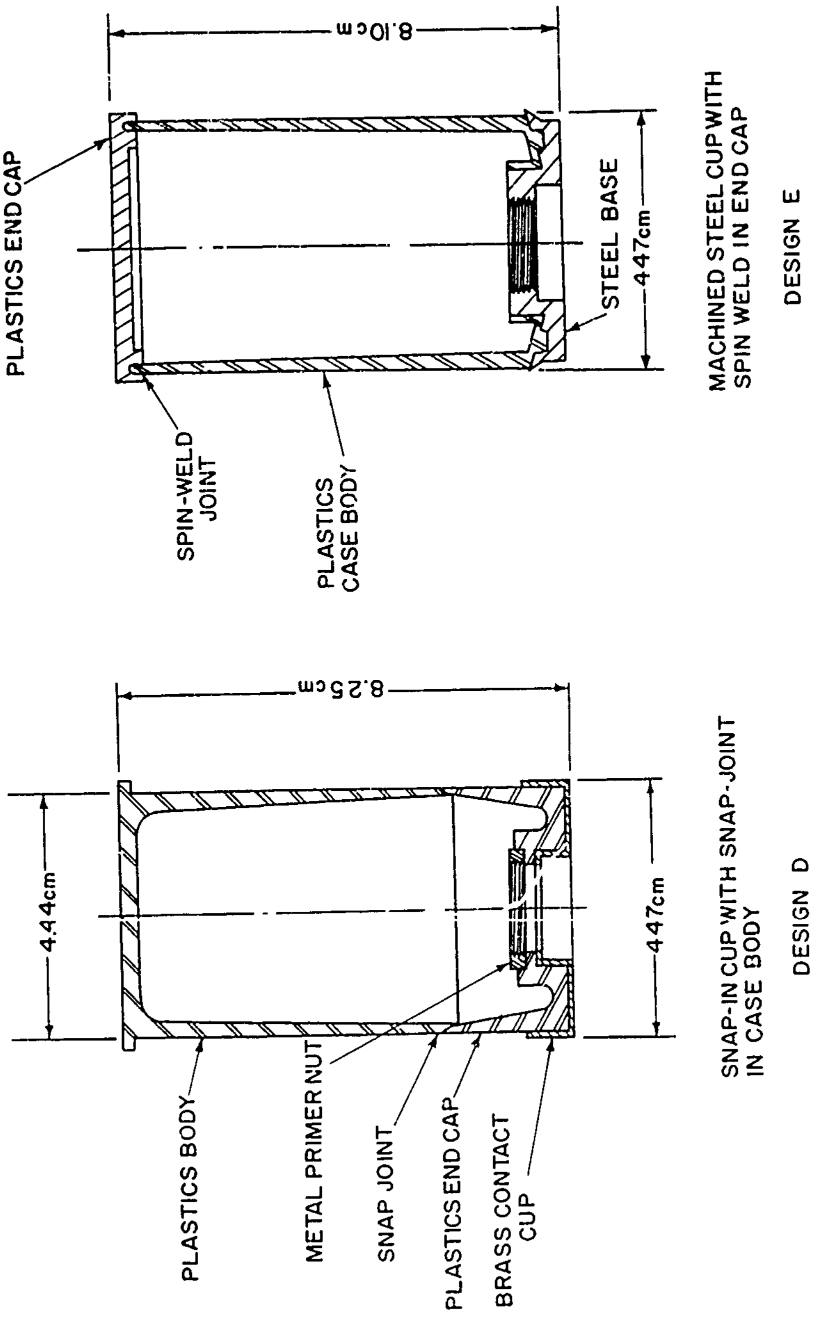


FIG. 5 PLASTICS PROJECTOR CHARGE CASE DESIGNS

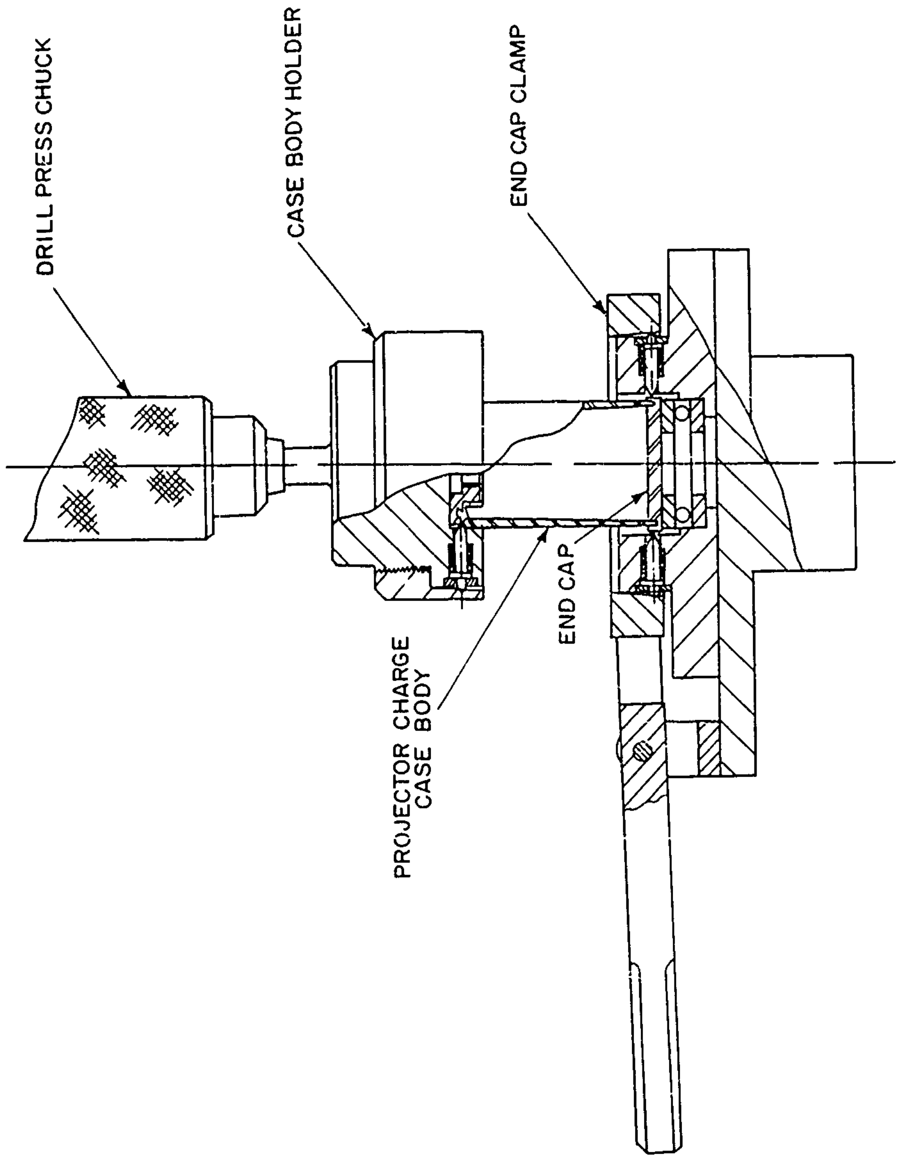


FIG 6 SPIN WELDING FIXTURE FOR PLASTICS PROJECTOR CHARGE CASE

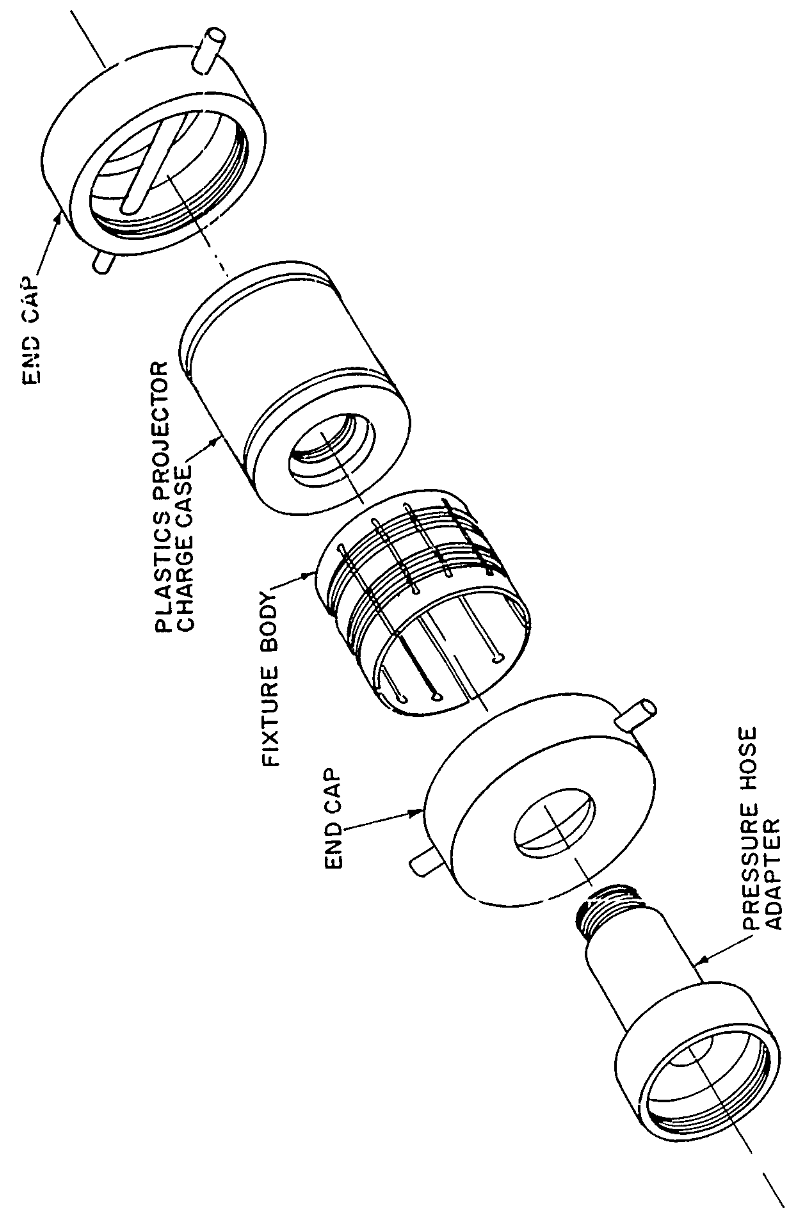


FIG. 7 SPIN WELDING TEST FIXTURE FOR PLASTICS PROJECTOR CHARGE CASE

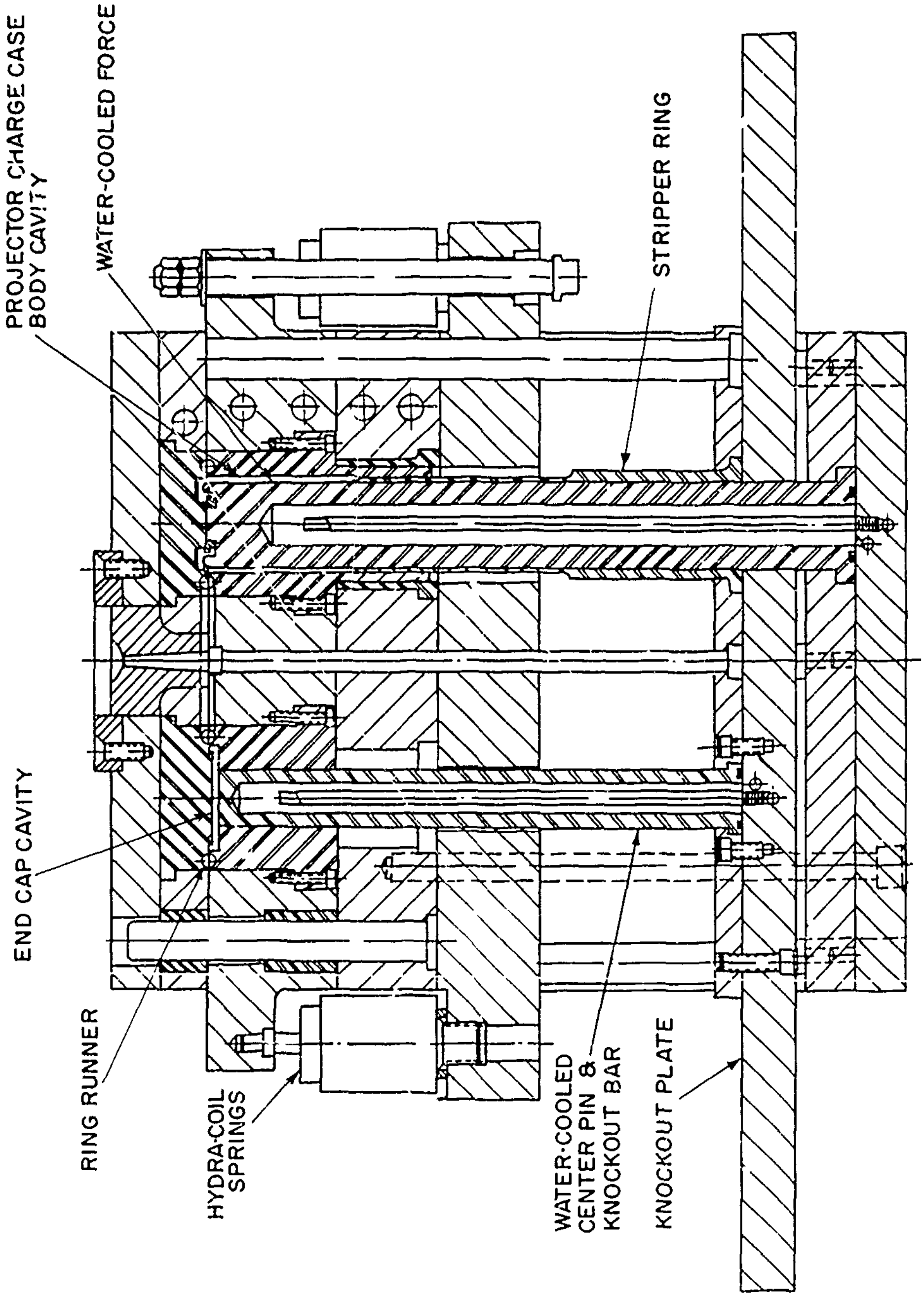


FIG. 8 SCHEMATIC DRAWING OF INJECTION MOLD DESIGN FOR PLASTICS PROJECTOR CHARGE CASE

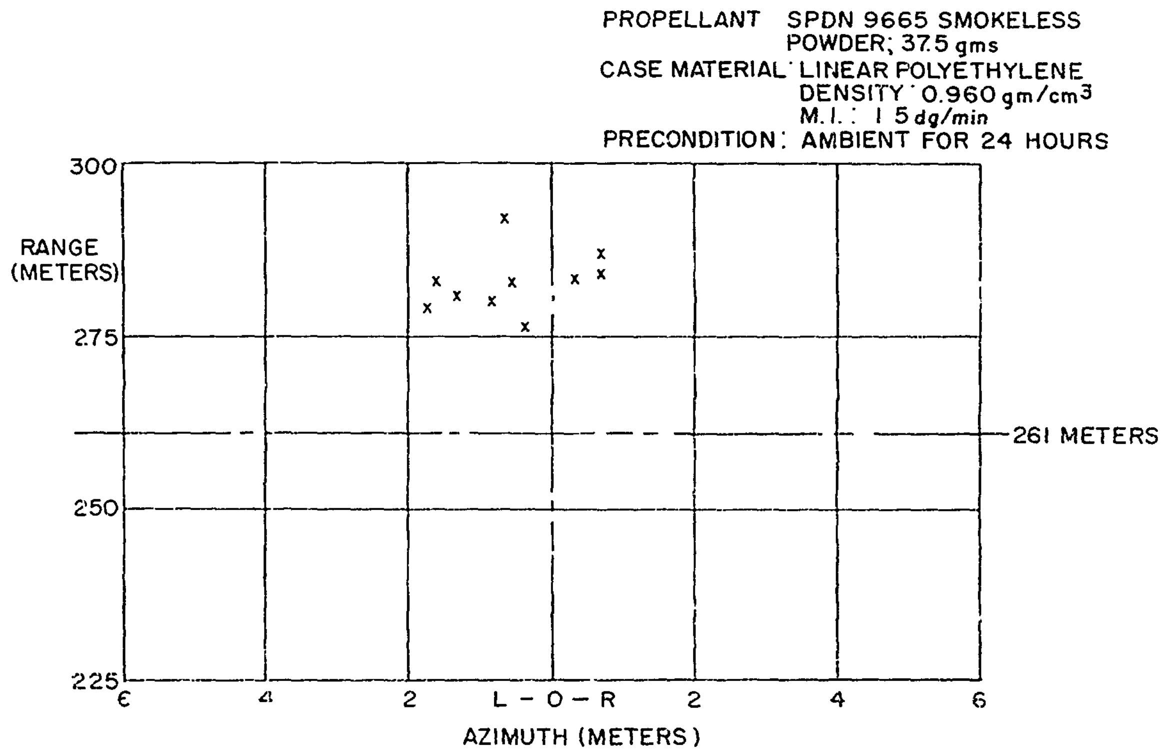


FIG 9 TYPICAL FIELD LOCATIONS FOR ROUNDS OF 7.2" ANTI-SUBMARINE WEAPON FIRED WITH DESIGN E PROJECTOR CHARGE CASE

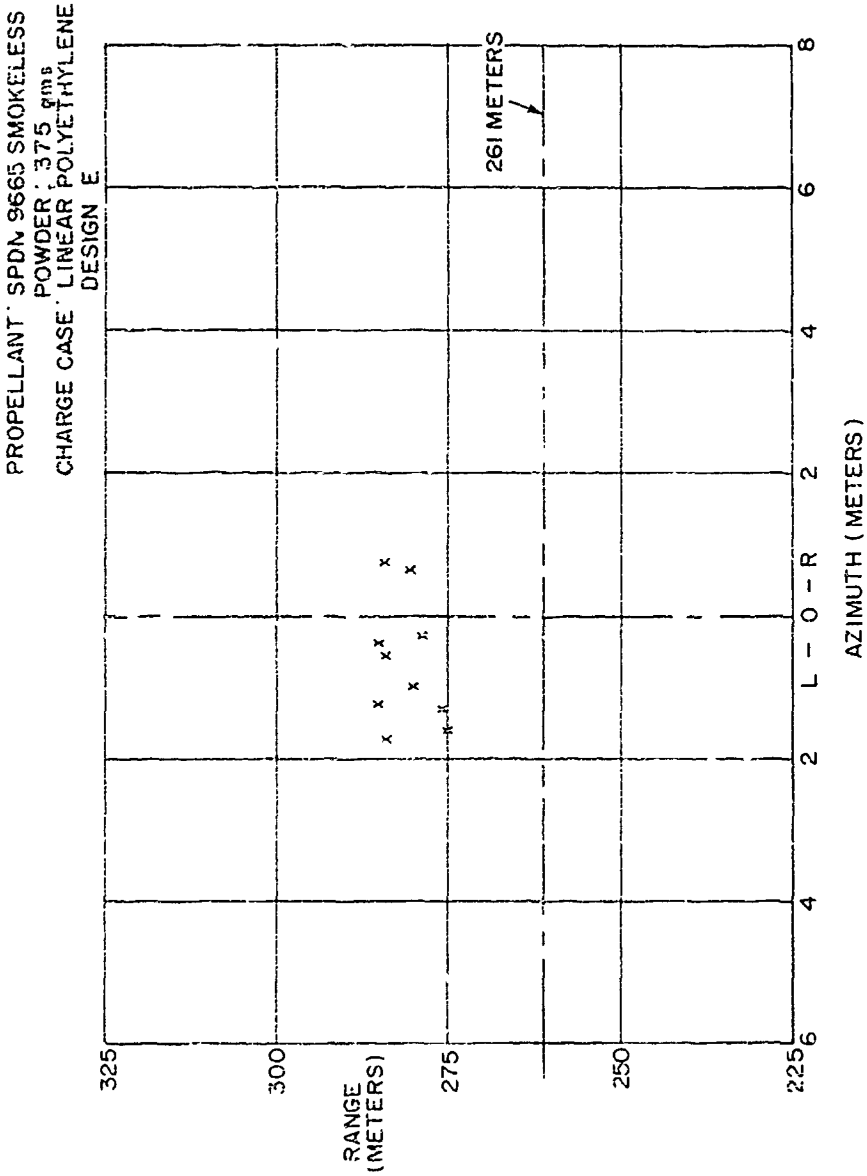
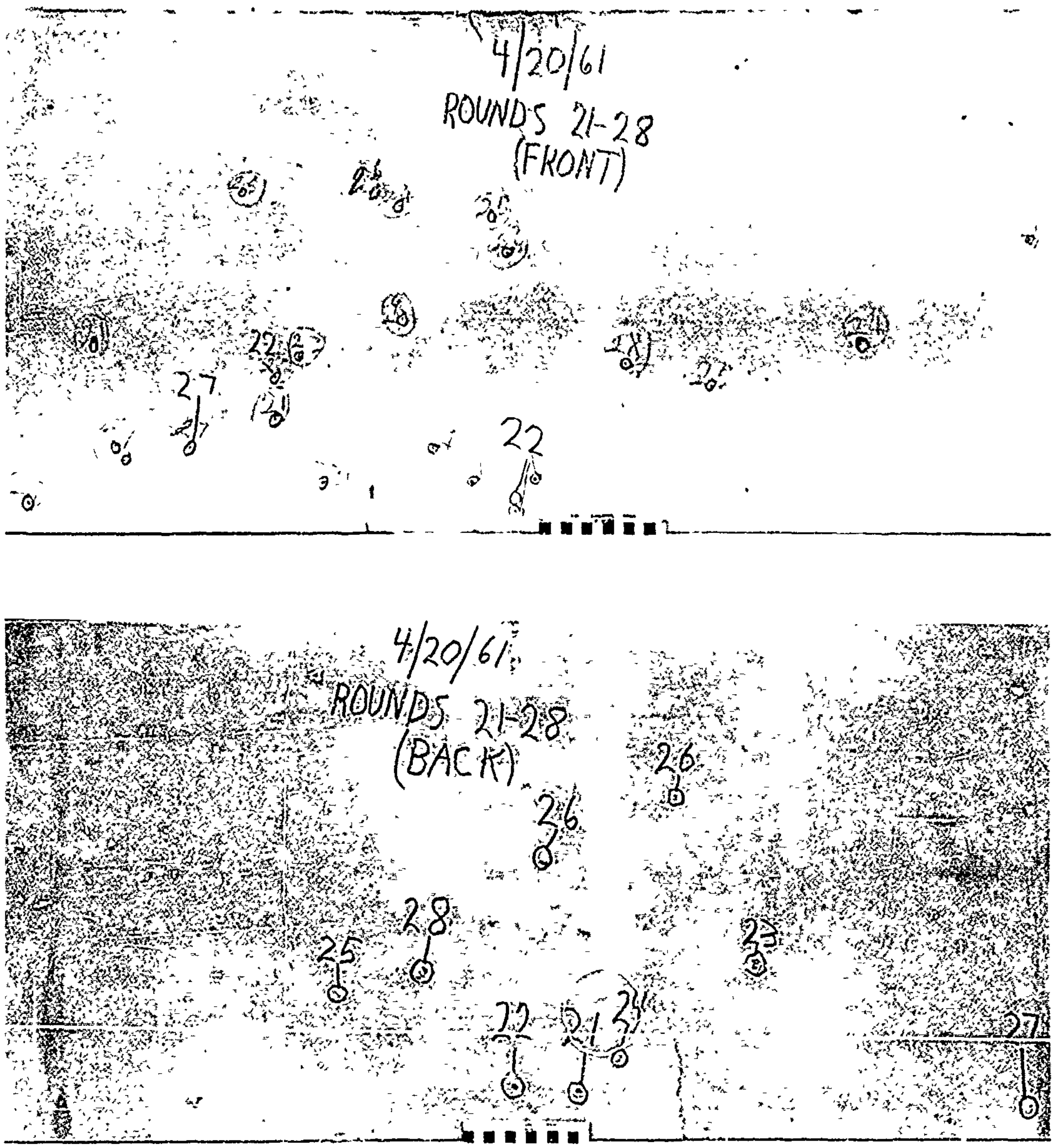


FIG 10 TYPICAL FIELD LOCATIONS FOR FIRED ROUNDS OF 7.2 ANTI-SUBMARINE WEAPON AFTER CHARGE CASE EXPOSURE TO 37 DAYS OF JAN. CYCLE.



CASE MATERIAL: LINEAR POLYETHYLENE
DENSITY: 0.960 gm/cm^3
M.I.: 1.5 dg/min

FIG 11 TYPICAL FRAGMENTATION PATTERN IN 1.7 cm CELOTEX SHIELD FOR FIRING OF DESIGN E PROJECTOR CHARGE CASES

TABLE 1

TYPICAL RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN A LINEAR POLYETHYLENE
PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at -18°C (0°F) for 24 hours						
A-1	242	793	5.2	17	0.9 R	3.0 R
A-2	239	782	8.6	28	2.2 R	7.2 R
A-3	245	803	2.1	7	2.5 L	8.1 L
A-4	259	850	12.2	40	0.4 L	1.4 L
A-5	250	821	3.4	11	0.7 R	2.3 R
Mean	248	810	6.3	20.6		
Conditioned at Ambient Temperature for 24 hours (27°C (80°F))						
A-6	246	805	6.1	20	1.2 L	4.0 L
A-7	251	823	0.6	2	1.8 L	6.0 L
A-8	261	855	9.2	30	2.3 L	7.4 L
A-9	257	841	4.9	16	0.9 R	3.1 R
A-10	244	801	9.3	24	1.6 R	5.2 R
Mean	252	825	5.6	18.5		
Conditioned at 52°C (125°F) for 24 hours						
A-11	272	891	6.1	20	2.4 R	8.0 R
A-12	263	862	2.7	9	2.0 L	6.4 L
A-13	258	847	7.3	24	1.0 L	3.2 L
A-14	261	888	5.2	17	1.8 L	5.9 L

TABLE 1 (continued)

TYPICAL RANGE RESULTS FOR 7".2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN A LINEAR POLYETHYLENE
PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at 52°C (125°F) for 24 hours						
A-15	265	869	0.6	2	1.3 R	4.3 R
Mean	266	871	4.4	14.4		

Propellant SPDN 9665 Smokeless Powder: 37.5 gm

L = To left of projected line of flight.

R = To right of projected line of flight.

NOTE: Averaged results for 70 brass projector charge cases fired at ambient conditions:

Mean Range: 256 meters, 841 feet

Range Spread: 20.1 meters, 66 feet

Deflection Spread: 6.7 meters, 22 feet

TABLE 2

TYPICAL RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN D LINEAR POLYETHYLENE
PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at -18°C (0°F) for 24 hours						
D-1	264	831	14	46	1.5 L	4.9 L
D-2	243	796	3.4	11	1.9 L	6.2 L
D-3	234	759	7.9	26	2.6 L	8.4 L
D-4	236	772	4.0	13	3.3 R	10.9 R
D-5	234	766	5.8	19	3.3 R	10.7 R
Mean	240	785	7.0	23.0		
Conditioned at Ambient Temperature for 24 hours (27°C (80°F))						
D-6	257	841	1.2	4	1.9 R	6.2 R
D-7	266	872	8.2	27	1.4 L	4.7 L
D-8	260	853	2.4	8	2.5 L	8.1 L
D-9	257	842	0.9	3	0.9 L	3.1 L
D-10	250	819	7.9	26	2.8 L	9.2 L
Mean	258	845	4.1	13.6		
Conditioned at 52°C (125°F) for 24 hours						
D-11	268	877	5.8	19	3.7 L	12.1 L
D-12	260	852	1.8	6	2.9 L	9.4 L
D-13	262	858	0	0	2.7 L	8.9 L
D-14	256	839	5.8	19	9.4 R	1.2 R

TABLE 2 (continued)

TYPICAL RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN D LINEAR POLYETHYLENE
PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at 52°C (125°F) for 24 hours						
D-15	264	864	1.8	6	1.0 R	3.4 R
Mean	262	858	3.0	10.0		

Propellant: SPDN 9665 Smokeless Powder, 37.5 gm

L = To left of projected line of flight.

R = To right of projected line of flight.

TABLE 3

TYPICAL RANGE RESULTS FOR 7"2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN E LINEAR POLYETHYLENE
PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at -18°C (0°F) for 24 hours						
E-1	251	822	6.7	22	1.2 L	3.9 L
E-2	262	859	4.6	15	0.9 L	2.8 L
E-3	260	851	2.1	7	0.3 R	1.0 R
E-4	257	842	0.6	2	0.1 R	0.4 R
E-5	259	848	1.2	4	1.0 L	3.2 L
Mean	258	844	3.0	10.0		
Conditioned at Ambient Temperature for 24 hours (27°C (80°F))						
E-6	269	881	1.5	5	0.9 R	2.9 R
E-7	266	873	0.9	3	0.4 R	1.4 R
E-8	271	889	4.0	13	0.3 L	1.0 L
E-9	265	869	2.1	7	2.0 L	6.4 L
E-10	264	866	3.0	10	1.6 L	5.1 L
Mean	267	876	2.3	7.6		
Conditioned at 52°C (125°F) for 24 hours						
E-11	272	891	1.2	4	1.0 L	3.4 L
E-12	268	880	4.6	15	1.3 R	4.2 R
E-13	276	905	3.0	10	1.2 R	4.0 R

TABLE 3 (continued)

TYPICAL RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH DESIGN E LINEAR POLYETHYLENE
PROJECTOR CHARGE CASE

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)
Conditioned at 52°C (125°F) for 24 hours						
E-14	277	907	3.7	12	0.9 L	3.1 L
E-15	272	893	0.6	2	0.7 R	2.3 R
Mean	273	895	2.6	8.6		

Propellant: SPDN 9665 Smokeless Powder, 37.5 gm

L = To left of projected line of flight.

R = To right of projected line of flight.

TABLE 4

SPIN-WELDING CONSTANTS FOR
PLASTICS PROJECTOR CHARGE CASE MATERIALS

Material	Load on Joint (Kg)	(lb)	Spinning Speed (RPM)	In-Motion Time (sec)
Linear Polyethylene (Marlex 6015) Density: 0.960 gm/cm^3 M.I.: 1.5 dg/min	181	400	390	2.5
Polypropylene Molding Material (Avisun, Type 10-14)	91	200	400	3.0
Polycarbonate Molding Material (Lexan, Grade 130-01)	171	375	500	3.5

TABLE 5

FAIL PRESSURE AND JOINT STRENGTH FOR
LINEAR POLYETHYLENE SPIN-WELDED CASES

Case No.	Maximum Internal Pressure at Failure		Ultimate Joint Strength	
	(Kg/cm^2)	(psi)	(Kg/cm^2)	(psi)
LP-50	47.8	680	293	4164
LP-51	45.7	650	280	3980
LP-52	52.0	740	318	4530
LP-53	50.6	720	310	4410
LP-54	49.2	700	299	4260
LP-55	49.2	700	302	4290
LP-56	51.3	730	314	4470
LP-57	47.4	675	291	4135
LP-58	48.5	690	297	4225
LP-59	49.9	710	306	4348

Load on Joint: 181 Kg (400 pounds)

Spinning Speed: 400 RPM

In-Motion Time: 2.5 seconds

TABLE 6

THE COMPATIBILITY OF PLASTICS PROJECTOR CHARGE CASE MATERIALS TO SMOKELESS POWDER (SPDN 9665)

Molding Material	Exposure Conditions	Tensile Strength After Test (Kg/cm^2)	(psi)	Change in Weight %
Linear Poly-ethylene (Marlex 6015) Density: 0.960 gm/cm^3 M.I.: 1.5 dg/min	5 Control Samples: (room temperature, no powder)	257	3660	0.000
	5 Samples: 2 weeks at 52°C (125°F)	257	3650	+0.010
	5 Samples: 2 weeks at 71°C (160°F)	246	3500	+0.046
	5 Samples: 4 weeks at 52°C (125°F)	237	3370	+0.012
	5 Samples: 4 weeks at 71°C (160°F)	245	3480	+0.108
Polycarbonate Molding Material (Lexan, Grade 130-01)	5 Control Samples: (room temperature, no powder)	588	8360	+0.030
	5 Samples: 2 weeks at 52°C (125°F)	620	8820	+0.015
	5 Samples: 2 weeks at 71°C (160°F)	610	8680	-0.036
	5 Samples: 4 weeks at 52°C (125°F)	590	8400	-0.017
	5 Samples: 4 weeks at 71°C (160°F)	617	8780	-0.055
Polypropylene Molding Material (Avisun, Type 10-14)	5 Control Samples: (room temp., no powder)	294	4180	+0.015
	5 Samples: 2 weeks at 52°C (125°F)	295	4195	+0.020

TABLE 6 (continued)

THE COMPATIBILITY OF PLASTICS PROJECTOR CHARGE CASE MATERIALS TO SMOKELESS POWDER (SPDN 9665)

Molding Material	Exposure Conditions	Tensile Strength After Test (Kg/cm²)	(psi)	Change in Weight %
Polypropylene Molding Material (Avisun, Type 10-14)	5 Samples: 2 weeks at 71°C (160°F)	287	4090	+0.031
	5 Samples: 2 weeks at 52°C (125°F)	287	4080	+0.019
	5 Samples: 4 weeks at 71°C (160°F)	288	4100	+0.042

TABLE 7

RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON FIRED WITH POLYPROPYLENE PROJECTOR CHARGE CASES AT AMBIENT CONDITIONS

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deviation from Min. Required Range of 261 M (855 ft) (meters)	(ft)	Deflection (meters)	(ft)
P-1	195	639	6.7	22	-56.7	-186	0	0
P-2	183	600	5.2	17	-77.8	-255	0.3 L	1.0 L
P-3	140	459	48.2	158	-120.8	-396	0.64R	2.1 R
P-4	212	696	24.1	79	-47.9	-157	0.55 L	1.8 L
P-5	205	672	16.8	55	-55.8	-183	0.37 L	1.2 L
P-6	151	495	37.2	122	-109.8	-360	0.37 R	1.2 R
P-7	197	645	8.5	28	-64.0	-210	0.55 L	1.8 L
P-8	196	642	7.6	25	-65.0	-213	0.37 L	1.2 L
P-9	213	699	25.0	82	-47.6	-156	0.37 L	1.2 L
P-10	190	624	2.1	7	-70.4	-231	0.82 L	2.7 L
Mean:	188	617	18.1	59.5	-71.7	-235		

Propellant: SPDN 9665 Smokeless Powder

Charge Weight: 37.5 gm

Pressure: Not recorded

L = To the left of projected line of flight.

R = To the right of projected line of flight.

TABLE 8

RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH POLYCARBONATE PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)	Internal Pressure (Kg/cm^2)	(psi)
Conditioned at -18°C (0°F) for 24 hours								
L-1	236	774	7.0	23	1.5 L	5.1 L	900	12,800
L-2	240	786	3.3	11	1.4 R	4.5 R	-	-
L-3	246	807	3.0	10	1.4 R	1.2 R	1,159	16,500
L-4	243	798	0.3	1	1.0 R	3.3 R	-	-
L-5	236	774	7.0	23	1.5 R	5.1 R	-	-
L-6	244	801	1.2	4	0.5 R	1.8 R	-	-
L-7	251	822	7.6	25	1.1 L	3.6 L	1,216	17,300
L-8	247	810	4.0	13	0.1 R	0.3 R	-	-
L-9	238	780	5.2	17	1.6 R	5.4 R	-	-
L-10	249	816	5.8	19	1.3 R	4.2 R	-	-
Mean	243	797	4.4	14.6			1,092	15,530
Conditioned at 22°C (72°F) (ambient) for 24 hours								
L-11	268	879	0.6	2	0.3 R	1.0 R	1,223	17,400
L-12	274	900	5.8	19	0.3 R	1.0 R	-	-
L-13	274	900	5.8	19	1.1 R	3.6 R	-	-
L-14	271	888	2.1	7	1.4 R	4.5 R	1,216	17,300
L-15	262	858	7.0	23	1.5 R	4.8 R	-	-
L-16	263	861	6.1	20	1.6 R	5.4 R	-	-
L-17	256	840	12.5	41	2.0 R	6.6 R	1,132	16,100

TABLE 8 (continued)

RANGE RESULTS FOR 7".2 ANTI-SUBMARINE WEAPON
FIRED WITH POLYCARBONATE PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)	Internal (Kg/cm^2)	Pressure (psi)
Conditioned at 22°C (72°F) (ambient) for 24 hours								
L-18	276	906	7.6	25	0.2 R	0.6 R	-	-
L-19	265	870	3.3	11	1.1 R	3.6 R	-	-
L-20	278	912	9.4	31	0.9 R	3.0 R	-	-
Mean	269	881	6.0	19.8			1,214	17,266
Conditioned at 52°C (125°F) for 24 hours								
L-21	266	873	11.9	39	1.9 R	6.3 R	1,244	17,700
L-22	285	936	4.3	14	2.1 R	6.9 R	-	-
L-23	284	933	3.3	11	0.4 R	1.2 R	-	-
L-24	284	930	2.4	8	2.1 R	6.9 R	1,265	18,000
L-25	282	924	0.6	2	1.5 R	4.8 R	1,279	18,200
L-26	285	936	4.3	14	0.1 R	0.3 R	-	-
L-27	284	933	3.3	11	0.5 L	1.8 L	-	-
L-28	274	897	7.6	25	0.9 L	3.0 L	-	-
L-29	287	942	6.1	20	1.9 R	6.3 R	1,582	22,500
L-30	280	918	1.2	4	1.7 R	5.7 R	-	-
Mean	281	922	4.5	14.8			1,343	19,100

Propellant: SPDN 9665 Smokeless Powder, 37.5 gm

L = To left of projected line of flight.

R = To right of projected line of flight.

TABLE 9

RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH LINEAR POLYETHYLENE PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)	Internal Pressure (Kg/cm^2)	(psi)
Conditioned at -18°C (0°F) for 24 hours								
PE-1	247	810	0	0	0.4 R	1.2 R	1,125	16,000
PE-2	241	789	6.4	21	0.6 L	2.1 L	1,082	15,400
PE-3	255	837	7.9	26	0.3 R	1.0 R	1,111	15,800
PE-4	258	846	11.0	36	0.8 L	2.7 L	1,167	16,600
PE-5	246	807	0.9	3	2.0 L	6.6 L	1,125	16,000
PE-6	238	780	9.1	30	0.6 L	2.1 L	-	-
PE-7	236	774	11.0	36	1.2 L	3.9 L	-	-
PE-8	260	852	12.8	42	1.4 L	4.5 L	-	-
PE-9	240	786	7.3	24	0.2 L	0.6 L	-	-
PE-10	250	819	2.7	9	1.2 L	3.9 L	-	-
Mean	247	810	6.9	22.8			1,122	15,960
Conditioned at 22°C (72°F) (ambient) for 24 hours								
PE-11	284	930	6.1	20	0.5 L	1.8 L	-	-
PE-12	283	927	5.2	17	2.8 R	9.3 R	-	-
PE-13	268	879	9.4	31	0.3 L	1.0 L	-	-
PE-14	279	915	1.5	5	1.7 L	5.7 L	-	-
PE-15	276	906	1.2	4	0.4 L	1.2 L	-	-
PE-16	284	933	7.0	23	0.6 R	2.1 R	-	-
PE-17	281	921	3.4	11	1.3 L	4.2 L	-	-

TABLE 9 (continued)

RANGE RESULTS FOR 7.2 ANTI-SUBMARINE WEAPON
FIRED WITH LINEAR POLYETHYLENE PROJECTOR CHARGE CASES

Case No.	Corrected Range (meters)	(ft)	Deviation from Mean Range (meters)	(ft)	Deflection (meters)	(ft)	Internal Pressure (Kg/cm^2)	(psi)
Conditioned at 22°C (72°F) (ambient) for 24 hours								
PE-18	276	906	1.2	4	1.6 L	5.4 L	-	-
PE-19	270	885	7.6	25	2.8 L	9.3 L	-	-
PE-20	275	903	2.1	7	1.0 L	3.3 L	-	-
Mean	278	910	4.5	14.7				
Conditioned at 52°C (125°F) for 24 hours								
PE-21	265	870	24.0	79	2.6 L	8.7 L	1,223	17,400
PE-22	290	951	0.6	2	1.2 L	3.9 L	1,300	18,500
PE-23	299	981	9.8	32	1.3 L	4.2 L	1,462	20,800
PE-24	281	921	8.5	28	3.9 L	12.9 L	1,462	20,800
PE-25	293	960	3.3	11	1.6 L	5.4 L	1,370	19,500
PE-26	297	975	7.9	26	1.1 L	3.6 L	1,385	19,700
PE-27	286	939	3.0	10	2.3 L	7.5 L	-	-
PE-28	288	945	1.2	4	1.5 L	4.8 L	-	-
PE-29	301	987	11.6	38	3.7 L	12.0 L	-	-
PE-30	293	960	3.3	11	3.0 L	9.9 L	-	-
Mean	289	949	7.3	24.1			1,367	19,450

Propellant: SPDN 9665 Smokeless Powder, 37.5 gm

L = To left of projected line of flight.

R = To right of projected line of flight.

TABLE 10

TYPICAL ELECTRICAL RESISTANCE OF DESIGN E
LINEAR POLYETHYLENE PROJECTOR CHARGE CASES
DURING EXPOSURE TO SALT FOG (MIL-STD-306)

Tail Tube Orientation	Daily Reading (ohms)				
	1	2	3	4	5
Horizontal	0.122	0.125	0.121	0.122	0.126
45° to Horizontal	0.150	0.145	0.130	0.135	0.145
Vertical - Primer Up	0.132	0.140	0.127	0.132	0.140
Vertical - Primer Down	0.135	0.130	0.133	0.125	0.130

NOTES:
1. All cases exposed in tail tubes.
2. Electrical circuit - through dummy primer.

TABLE 11

TYPICAL COMPRESSIVE CREEP RESULTS FOR DESIGN E
LINEAR POLYETHYLENE PROJECTOR CHARGE CASES
MOUNTED IN TAIL TUBES

Case No.	Load on Cases (Kg)	Load on Cases (lb)	Total Compressive Creep After 5 Weeks Exposure (cm/cm)
E-31	29.5	65	0.0003
E-32	29.5	65	0.0010
E-33	29.5	65	0.0030
E-34	29.5	65	0.0023
E-35	29.5	65	0.0020
E-36	29.5	65	0.0010
E-37	29.5	65	0.0008
E-38	29.5	65	0.0013
E-39	29.5	65	0.0004
E-40	29.5	65	0.0019

TABLE 12

TYPICAL WATER PICKUP RESULTS FOR DESIGN E
LINEAR POLYETHYLENE PROJECTOR CHARGE CASES
AFTER 4 WEEKS ON JAN CYCLING (MIL-STD-354)

Case No.	Initial Weight of Case and Silica Gel (gm)	Final Weight of Case and Silica Gel (gm)	Total Water Pickup (gm)
E-41	163.4	163.4	0.0
E-42	166.8	167.0	0.2
E-43	168.5	168.8	0.3
E-44	168.6	169.0	0.4
E-45	169.0	169.6	0.6
E-46	167.8	168.3	0.5
E-47	165.4	165.6	0.2
E-48	168.1	168.4	0.3
E-49	167.5	167.8	0.3
E-50	164.9	165.4	0.5

TABLE 13

SUGGESTED INJECTION MOLDING CYCLE FOR
LINEAR POLYETHYLENE MOLDING MATERIAL

Material Used: Marlex 6015; density 0.960 gm/cm^3; M. I. 1.5 dg/min.

Heating Cylinder Temperature: Top 210°C; bottom 230°C.

Mold Temperature: 24.0°C

Injection Ram Pressure: 1265 Kg/cm^2

Injection Ram Forward Time: 20 sec

Holding Time: 25 sec

Equipment: Watson-Stillman 350 gm, in-line piston type injection press.

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BIBLIOGRAPHIC INFORMATION

	DESCRIPTORS	CODES		DESCRIPTORS	CODES
SOURCE	NOL Technical report	NOLTR	SECURITY CLASSIFICATION AND CODE COUNT	Unclassified - 33	UØ33
REPORT NUMBER	63-148	63Ø148	CIRCULATION LIMITATION		
REPORT DATE	18 June 1963	Ø663	CIRCULATION LIMITATION OR BIBLIOGRAPHIC		
			BIBLIOGRAPHIC (SUPPL., VOL., ETC.)		

SUBJECT ANALYSIS OF REPORT

DESCRIPTORS	CODES	DESCRIPTORS	CODES	DESCRIPTORS	CODES
Plastic	PLAS	Replacement	RPLA	Hazard	HAZA
Charge	CHAR	Metal	META	Personnel	PERS
Case	CASE	Increase	INCR	Requirements	REQI
Projector	PROE	Range	RANG	Case (Design)	CASED
Anti-submarine	ANTS	Water	WATR	Spin	SPIN
Weapon	WEAP	Leakage	LEAK	Welding	WELD
Hedgehog	HEDG	Storage	STOR	Mold (Design)	MOLDD
Depth charge	DEPC	Salt	SALT	Mold	MOLD
7X2	7X2Ø	Corrosion	CORR	Materials	MATE
High	HIGH	Sea water	SEAA		
Density	DENS	Cost	COST		
Polyethylene	POLH	Reduction	REDC		

PRNC-NOL-5070/28 (5-62)

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DEVELOPMENT OF A PLASTICS CHARGE CASE FOR THE 7"2 PROJECTOR CHARGE ANTI-SUBMARINE WEAPON (U), by M. A. Kinna and S. P. Prosen. 18 June 1963. 6p. illus., tables. BuWeps task RUSD 2A-C00/212-1/F008-15-003. UNCLASSIFIED

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1. Charges, Depth - Cases
2. Charges, Depth - Hedgehog
3. Cases, Plastic
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IV. Project

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